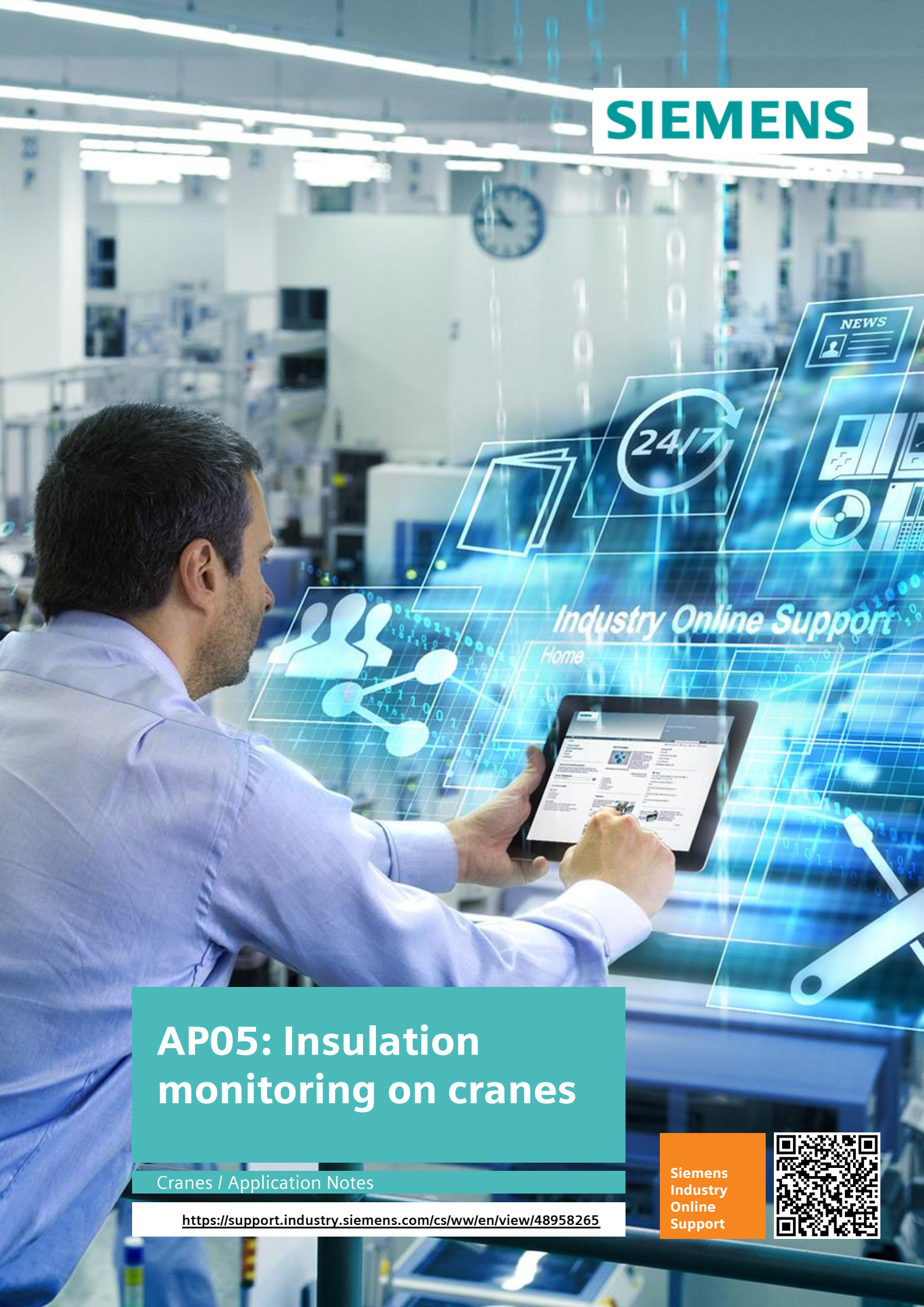


A man in a light blue shirt is seen from the side, holding a tablet. He is in a factory or industrial setting with various machines and equipment in the background. Overlaid on the image are several digital graphics: a Siemens logo in the top right, a '24/7' circular icon, a 'NEWS' section with a person icon, a 'Home' button, and a network diagram with three people icons. The text 'Industry Online Support' is also visible.

SIEMENS

AP05: Insulation monitoring on cranes

Cranes / Application Notes

<https://support.industry.siemens.com/cs/ww/en/view/48958265>

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1 Introduction

1.1 Power supply systems

The various types of distribution systems are described in IEC 60364-5-51. The various types result from the different treatment of the neutral point of the system (earthed or insulated) in conjunction with the possibilities of earthing exposed conductive parts [3].

Protection of people and animals against hazardous body currents is basically regulated in IEC 60364-4-41. These standards define the measures for protection against direct contact, as well as in case of indirect contact.

The special requirements for insulation monitoring devices are stipulated in IEC 61557-8, EN 61557-8. This document describes devices which are used in pure AC systems, as well as devices which are used in AC, DC and mixed AC/DC systems. IEC 61557-8 (EN 61557-8) is very precise with respect to the special requirements for devices, type of construction, measuring technology, documentation and tests /inspections. IEC 61557-9, EN 61557-9 regulates the requirements for insulation fault location systems [4, 5, 6, 7].

The safety degree is influenced by many factors that can be categorized essentially into the following three hazard groups [5]:

- hazards through faulty devices
- hazards through faulty application
- hazards through procedural causes

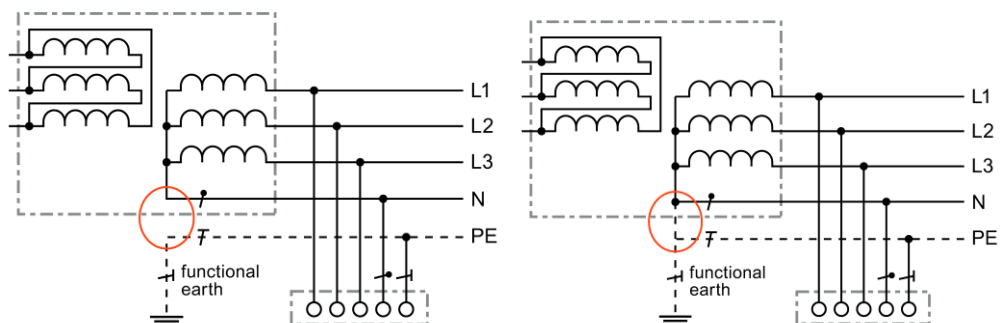
The measures to protect against life hazards have top priority when installing power supply systems. All other protective measures such as lightning, surge protection and insulation monitoring (IMD) of electrical systems and installations are secondary to the protective measures taken against indirect contact.

In IT systems all active parts either are insulated from earth or one point is connected to earth through a sufficiently high impedance; see the following figure.

1.2 Insulated earth (IT) power distribution for cranes

Crane drive systems with insulated earth (IT supply) provide the crane end-user with a higher availability as compared to drive systems with the neutral earthed (TN supply). Whereas a ground fault in a TN system immediately leads to a large short circuit current and thus tripping of protective devices (circuit breaker) and thus system shutdown, an IT system can continue to operate for a number of hours before a second fault occurs. Only a second ground fault would lead to a large short circuit current and thus to a system tripping.

Figure 1-1 Basic configuration of IT (left) and TN (right) distribution



Based on this consideration, it is feasible that a crane on which a ground fault has occurred continues to work a vessel for a certain period of time, either till the vessel is cleared or till another crane is available to take over.

1.3 Surge Protective Devices (SPDs)

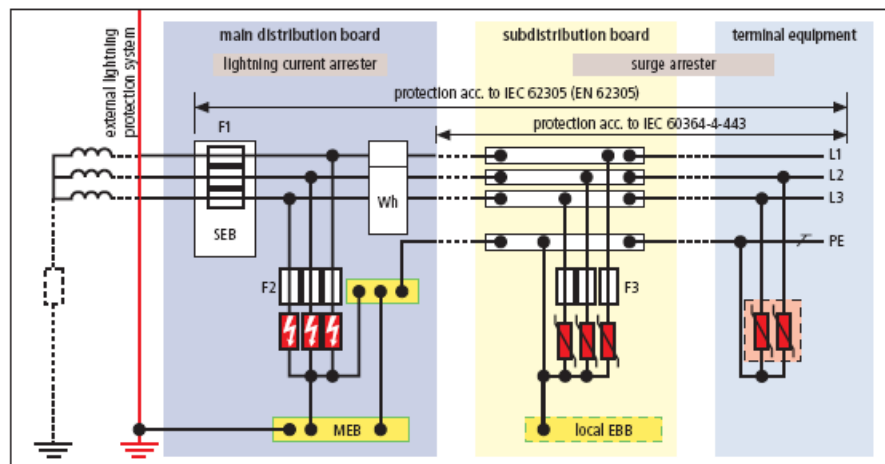
The main function of a protective device (type 3) in IT systems is to protect the equipment against surges arising between L and N in the electrical system – Maximum continuous voltage U_c . The U_c voltage (equal to: rated voltage) is the root mean square (rms) value of the maximum voltage which may be applied to the correspondingly marked terminals of the surge protective device during operation. It is the maximum voltage on the arrester in the defined non-conductive state which ensures that this state is regained after it has responded and discharged, see detailed information on internet site (<http://www.dehn.de>)^[6].

The value of U_c shall be selected in accordance with the nominal voltage of the system to be protected and the requirements of the installation provisions (IEC 60364-5-53/A2).

For IT supplied systems we recommend surge arrestors with a maximum continuous voltage U_c of 600 V for < 500 V infeed and U_c of 1000 V for > 500 V infeed.

NOTE Incorrectly selected surge arrestors will influence the operation of the insulation monitoring devices.

Figure 1-2 IT system with Surge Protective Devices (SPDs)



1.4 Insulation Monitoring Devices (IMDs)

When operating an IT system, it has to be considered that "first fault" changes an initially unearthed system (IT system) into an earthed system (TN or TT system) and that a further fault may lead to the tripping of circuit breakers and hence lead to disconnection.

Experience has shown that the single fault (first fault) is the most likely type of fault to occur (> 90 %) and the risk of hazards due to a second fault are regarded to be very unlikely. This fact is taken into account in the standard IEC 60364-4-41 where

it is recommended that a first insulation fault should be eliminated with the shortest possible practical delay and therefore an IT system must always be equipped with an insulation monitoring device for warning and controlled switching off of the equipment.

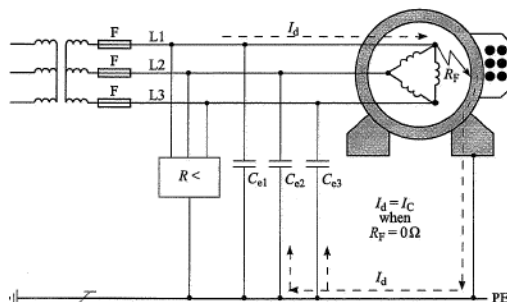
A detailed description of the requirements for an insulation monitoring device is given in IEC 61557-8: 1998-05.

The latest international standard IEC 61557-8:2007-12 specifies the requirements for insulation monitoring devices which are used in systems up to AC 1000 V and DC 1500 V, independent of the measuring principle [5].

Improved availability of supply – a substantial aspect – is guaranteed with the IT system. When operating an IT system at single fault condition, attention has to be given to the fact that the originally ungrounded (IT) system has turned into a grounded system (TN, TT); see figure 1-3. An additional fault could then lead to triggering the short-circuit protection thereby switching off the system. To prevent this occurrence, the insulation resistance is permanently monitored through an IMD.

As an IMD we recommend Bender Insulation Monitoring Device type **iso685**; see chapters *General menu structure of Bender iso685* and *Recommended settings for Bender iso685 in crane applications with IT supply*; see also <http://www.bender-de.com> [4]

Figure 1-3 IT with IMD monitoring



The essential advantage of an IT system is already evident in the event of a single fault condition. Only a small current I_F flows, the value of which is determined through the system leakage capacitance C_E . This does not trigger a fuse, the supply voltage is maintained and the operation of the installation preserved.

The advantage of the IT system is the following: since the supply is fully floating from earth, a fault to earth on one of the two lines will normally only produce a very small fault current which is too low to fuse the supply. The magnitude of the fault current is primarily limited by the system leakage capacitance. Hence the supply remains secure and repairs can be effected to remove the fault at a time suitable to the maintenance engineers or maintenance staff.

Should a fault to earth on the second of the two lines occur before the first fault has been cleared, a high fault current will flow and fuse the supply protection, resulting in interruption of the signaling supply. This means that it is extremely important that

an alarm indication of the first fault is reported to engineers so that they can locate the fault before the supply trips.

It is to be considered by the end-user that in the IT system while operating with an earth fault in one of the phase conductors on either the drive input or output, the other two phases will be subjected to approx. 1.73 times increased voltage stress. This elevated voltage stress is particularly critical for the insulation system of motors.

In general operating of any LV-motor under such conditions will lead to significantly reduced winding life span. It is therefore necessary to limit the exposure of the system to a higher voltage stress to only a few hours.

In compliance with IEC 60204-32, clause 8.2.1 all drive systems engineered by Siemens (MASTERDRIVES and SINAMICS) are equipped with an insulation monitoring device – type Bender **iso685**. Chapter *General menu structure of Bender iso685* shows all relevant settings for the IMD type **iso685**. Save monitoring is only secured when the basic configuration complies with the Siemens basic crane configurations [7].

Figure 1-4 Bender insulation device iso685



This Insulation Monitoring Device with its Adaptive pulse Measurement System (AMP) is particularly suitable to measure the insulation resistance on drive system with PWM modulated IGBT converters and provides on its display an insulation resistance reading in kOhm. Basic operating principles and details about the IMDs are given in different publications from Bender[4].

The **iso685** allows programming of two insulation resistance alarm thresholds:

- Threshold 1 should be set sufficiently below the normal insulation resistance value and cause the crane monitoring system to issue to maintenance staff the instruction to check the system components for a gradual deterioration of the insulation resistance. This check should comprise:
 - Insulation resistance measurement of all main drive system motors
 - Visual inspection of all drive system cables for mechanical damage
 - Visual inspection of all cable termination points for ground faults and water ingress
- Threshold 2 which is to be set below threshold 1 should start a timer which forces the crane to shut down after a set time has elapsed.

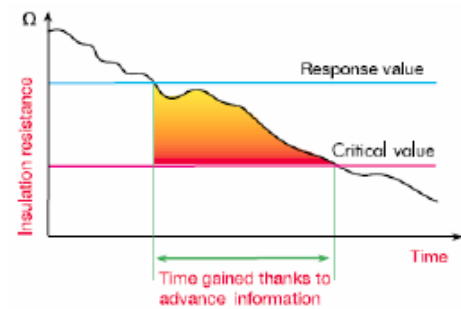
NOTE

The recommended values for thresholds 1 and 2 are given in chapter *General menu structure of Bender iso685*

Figure 1-6 Example of earth fault in junction box containing multiple motor feeder cables



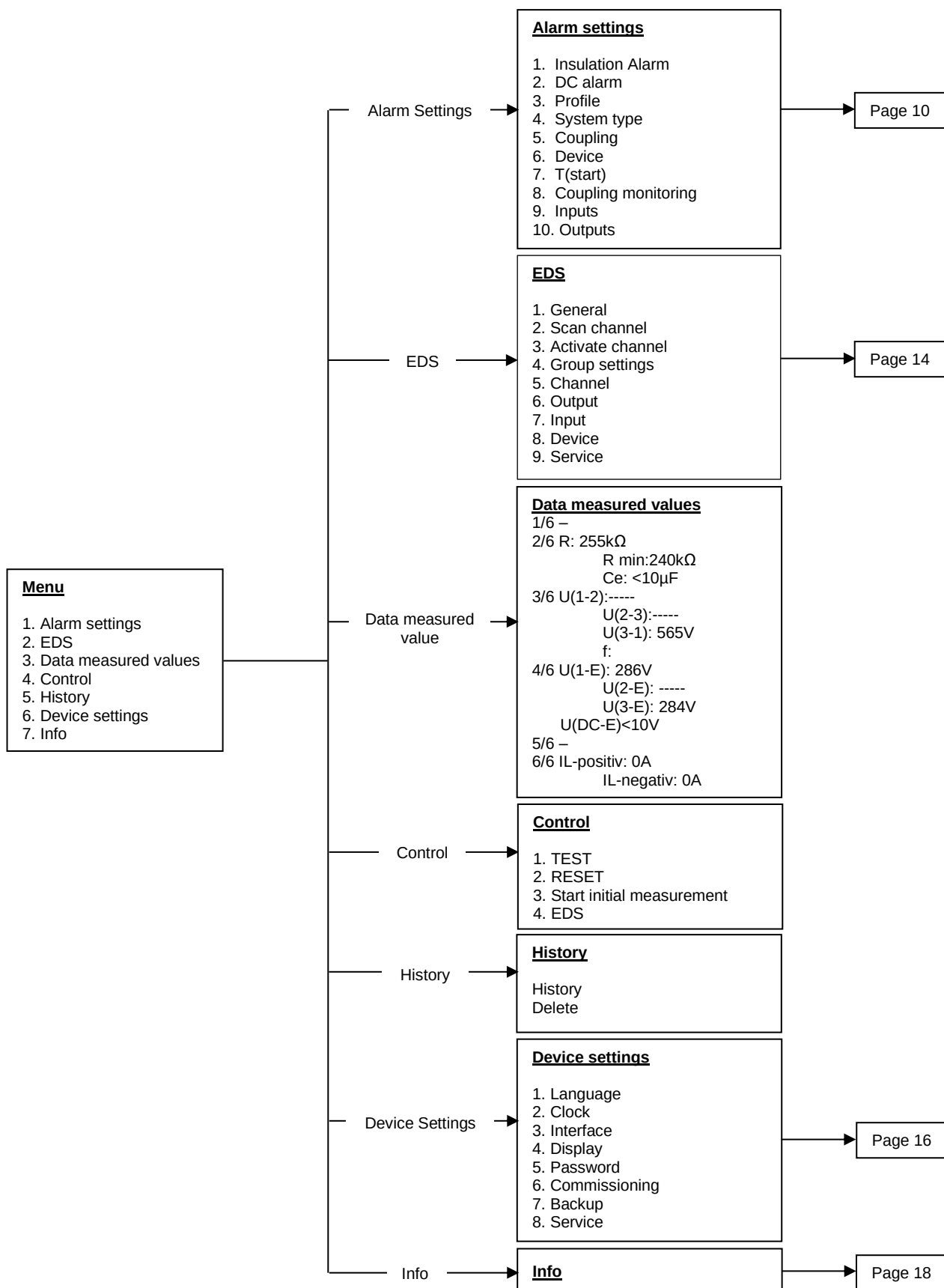
Figure 1-5 Estimating Electric Motor Life Using Motor Circuit Analysis

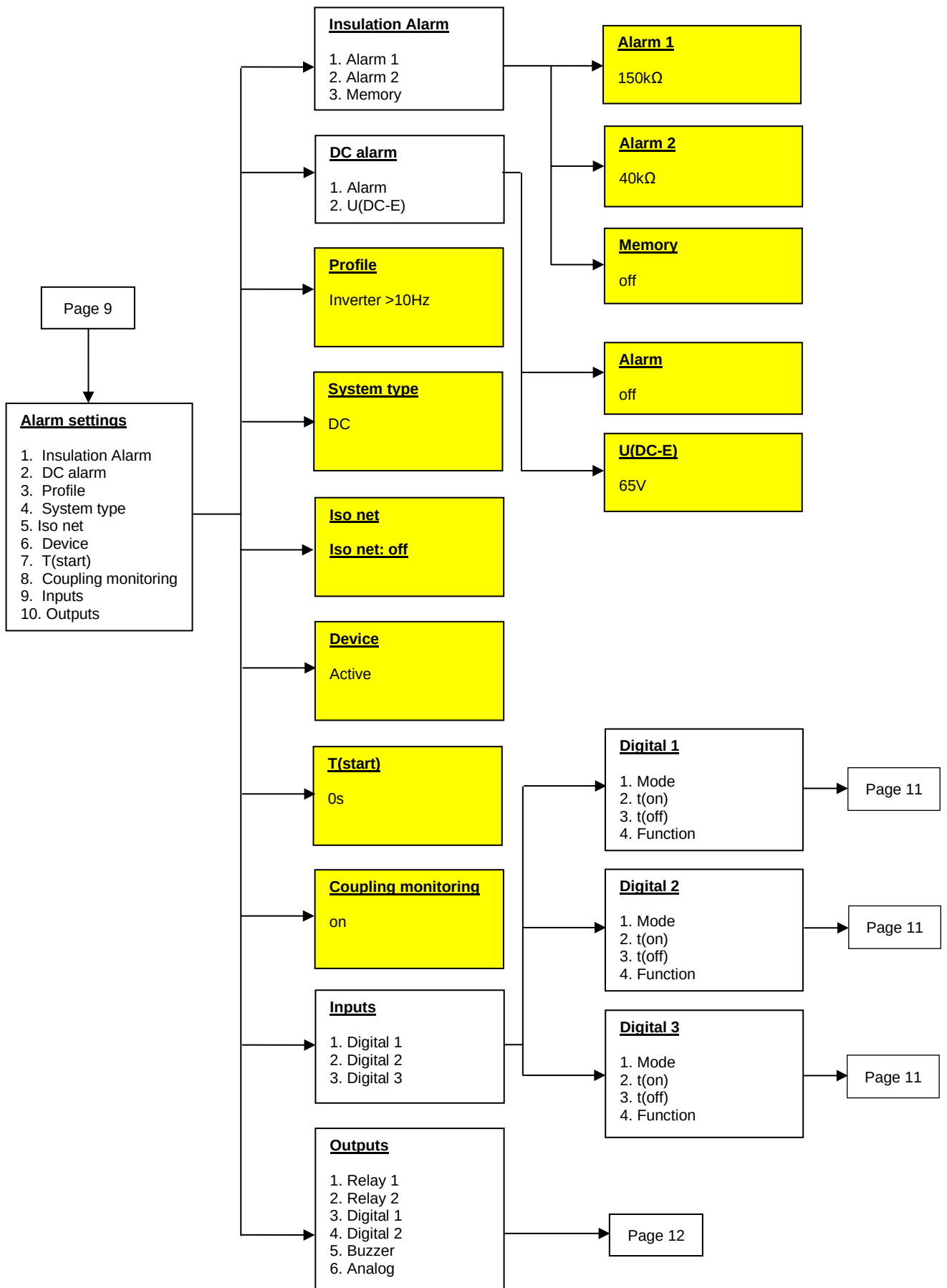


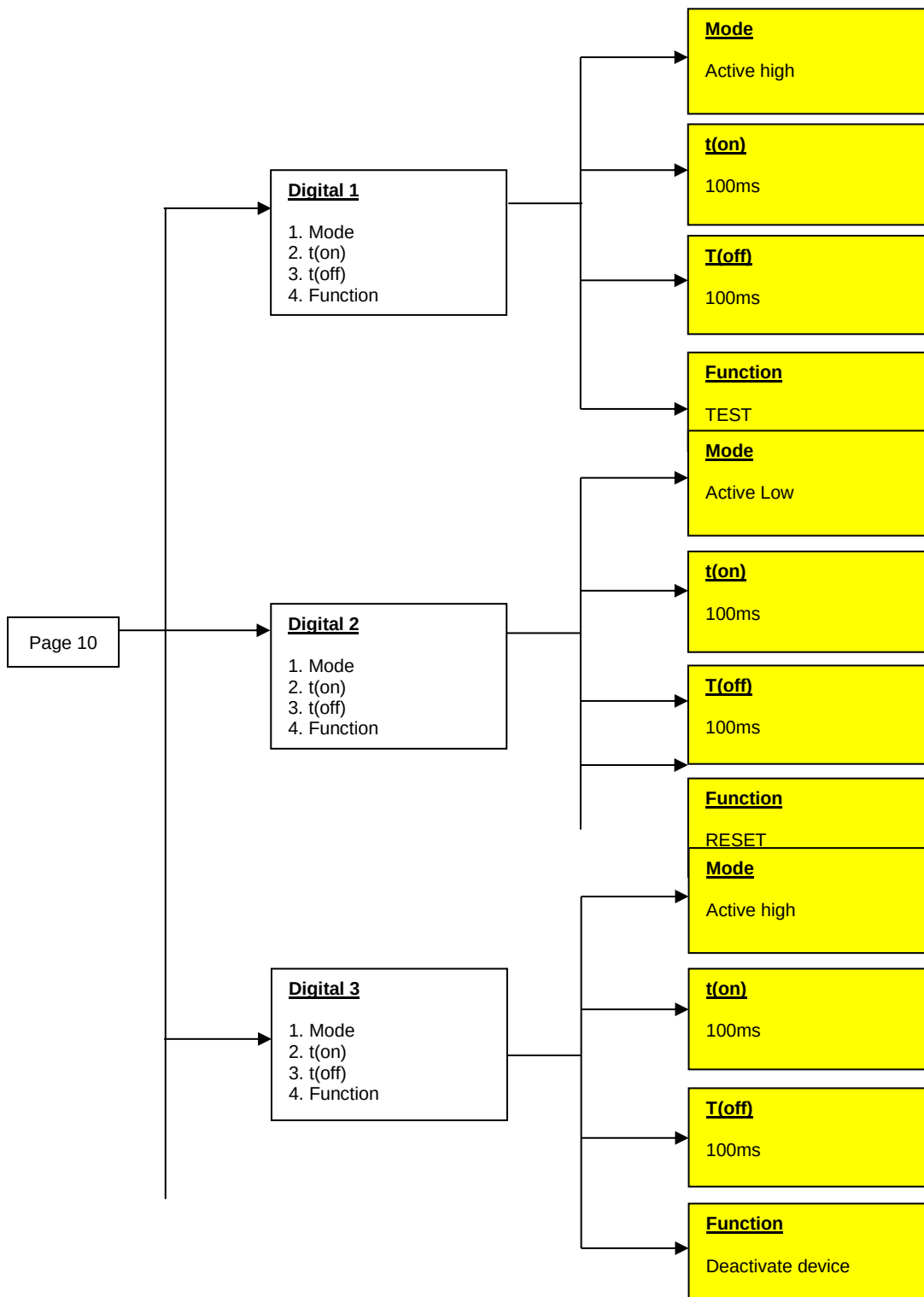
It is decisive to have early information about a possible fault in the insulation resistance. With an insulation monitoring device, e. g. Bender iso685 which has an analog output, you have the required information as early as possible. This functionality can be integrated in the SIMOCRANE Crane Management System and the insulation degradation can be monitored and corrective measures can be taken.

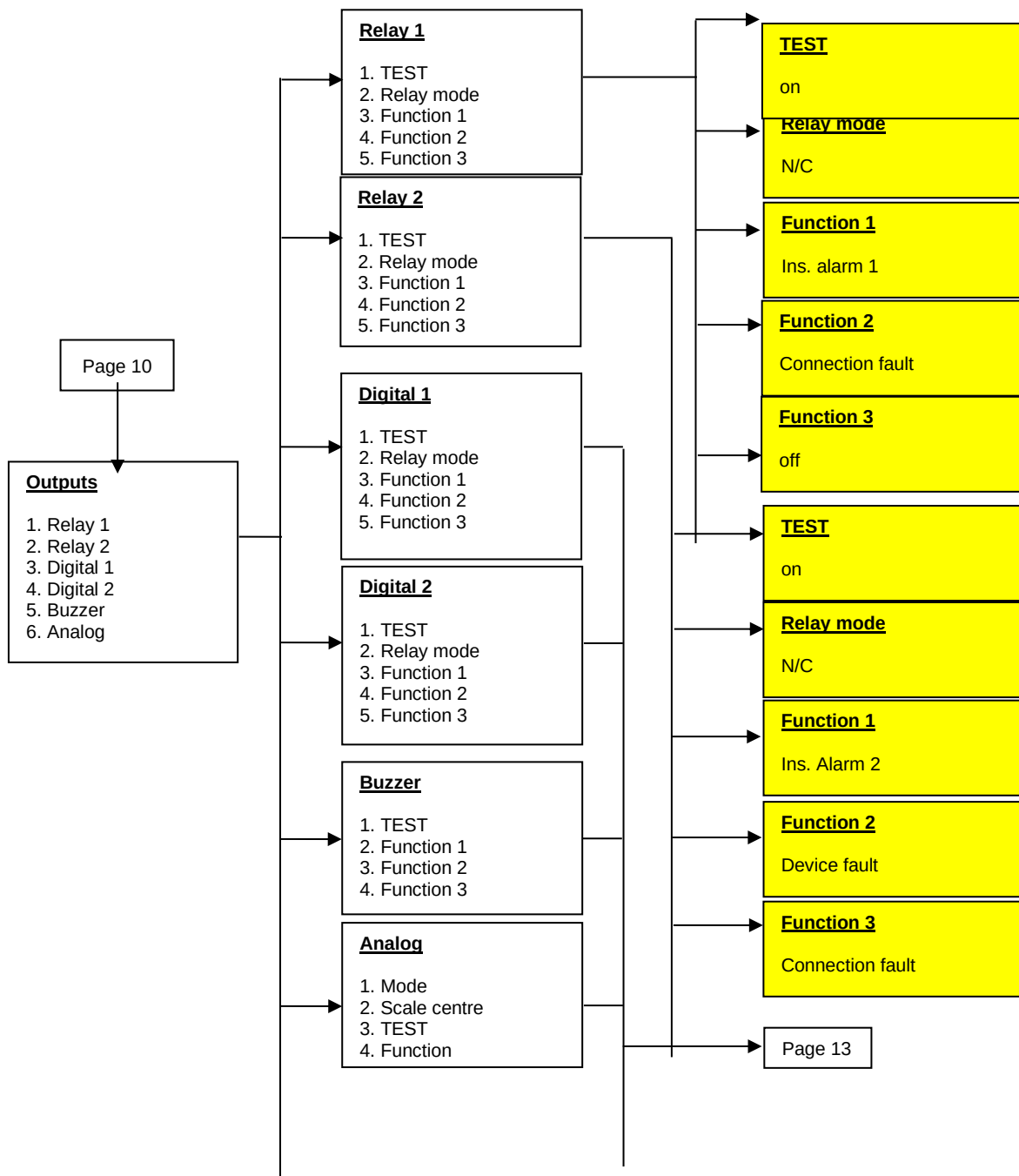
2 Additional information

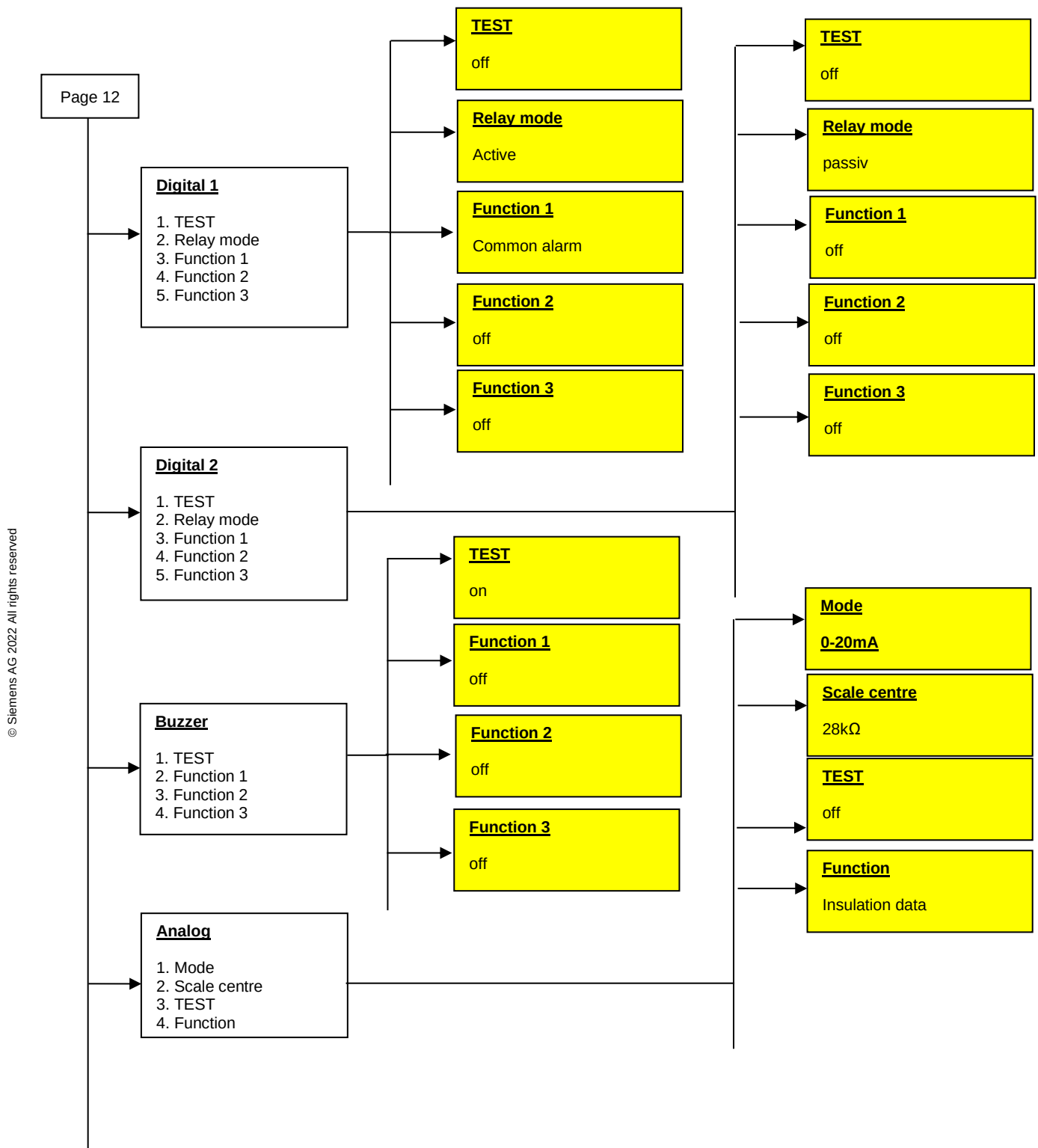
2.1 General menu structure of Bender iso685

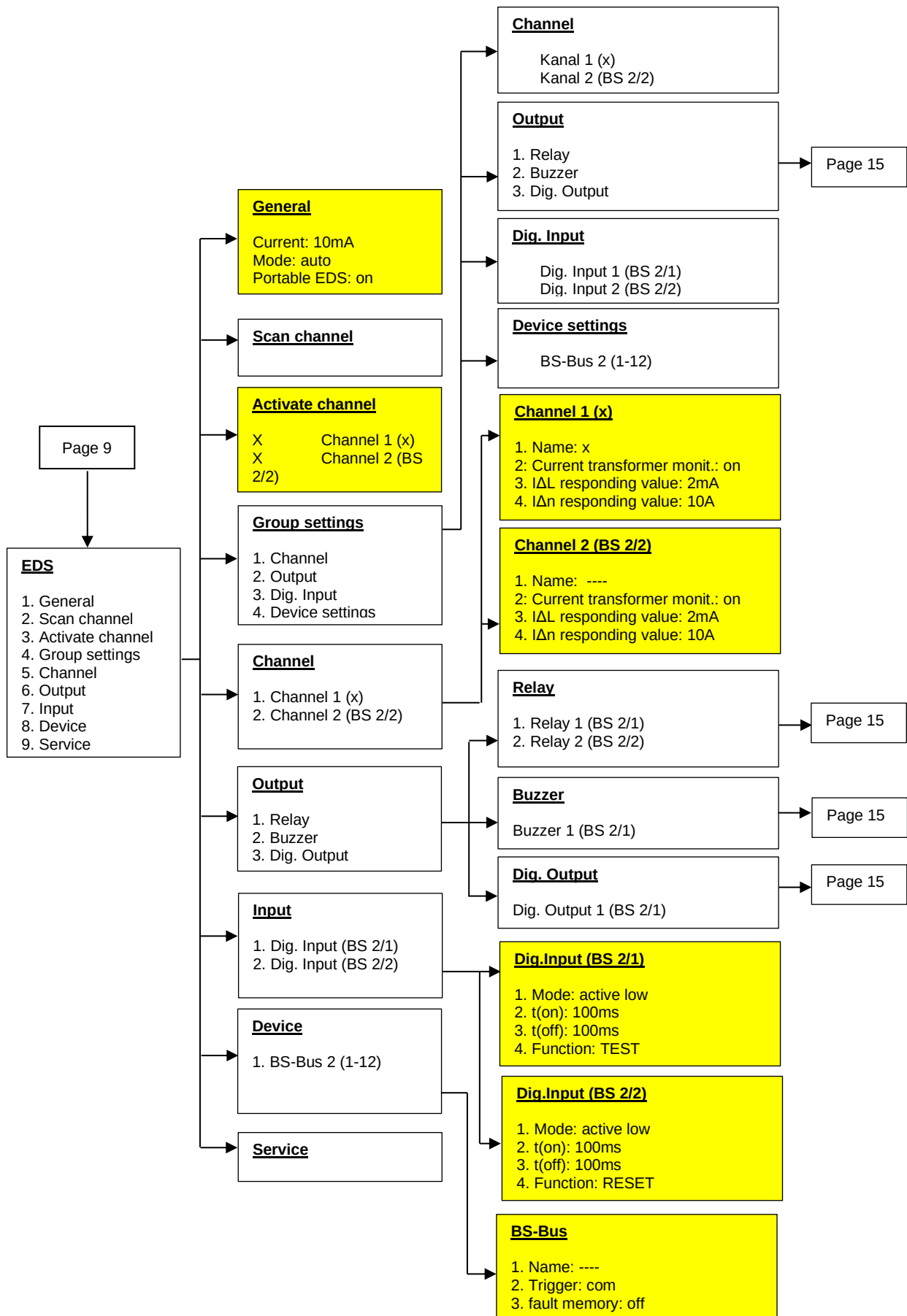


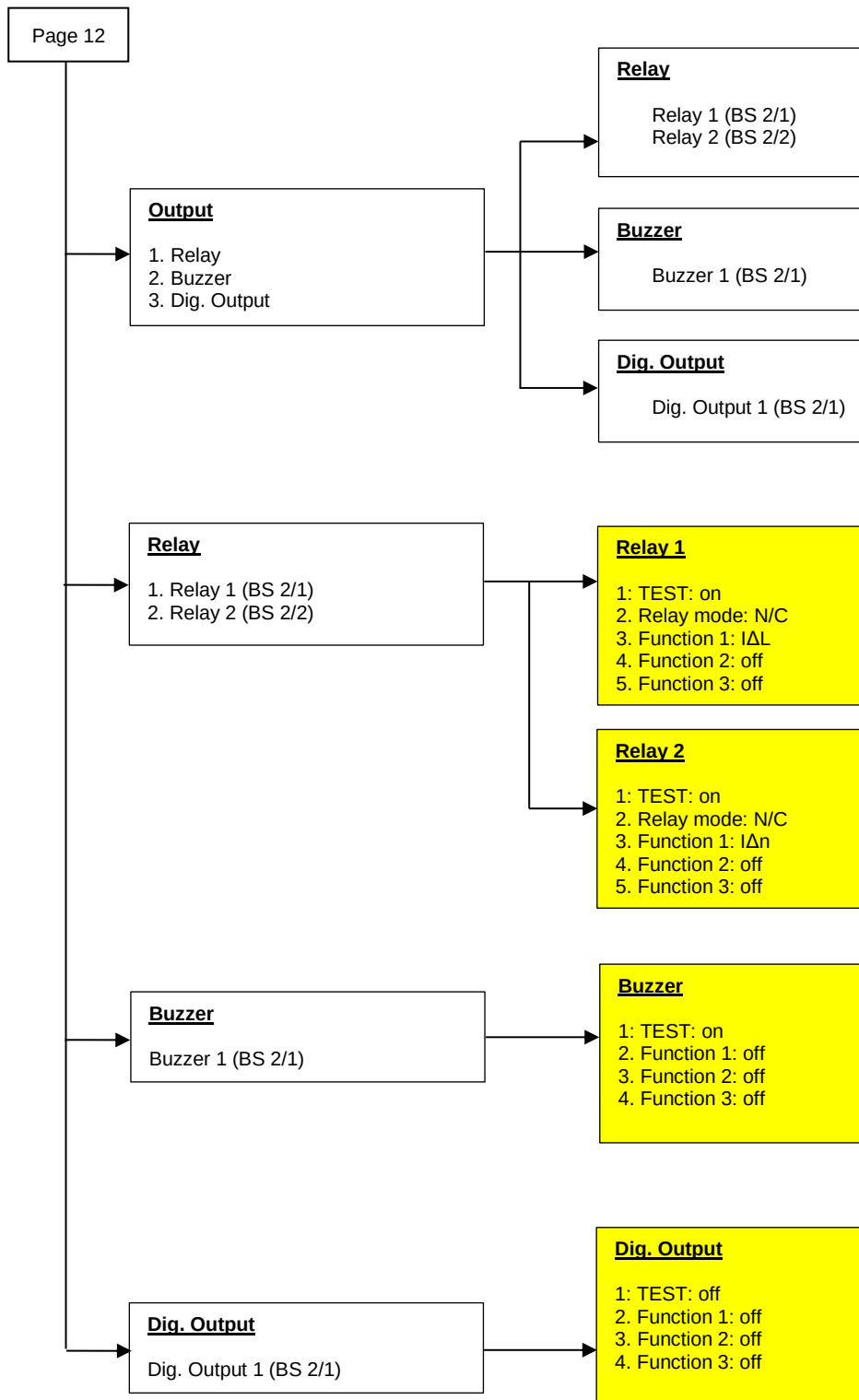


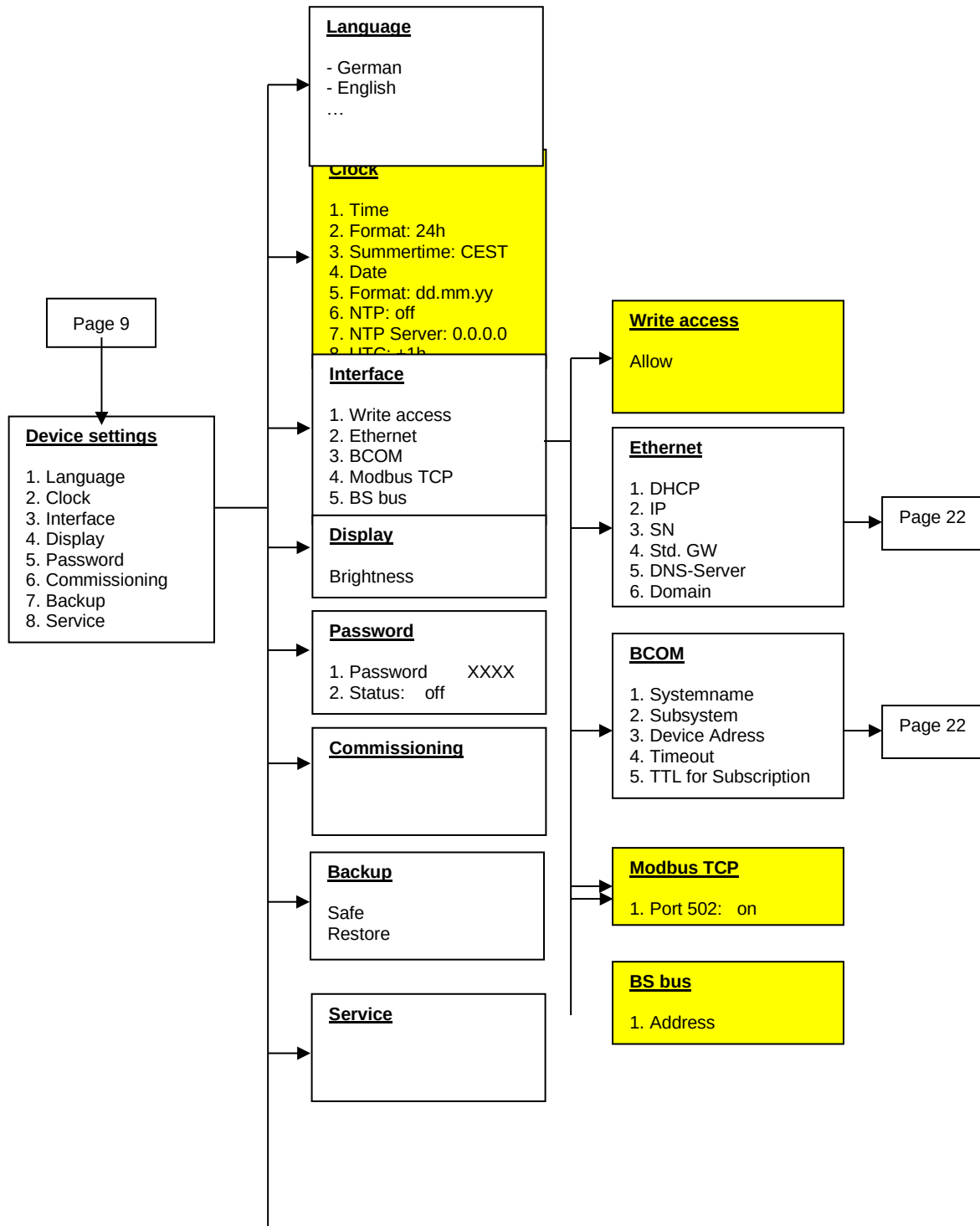


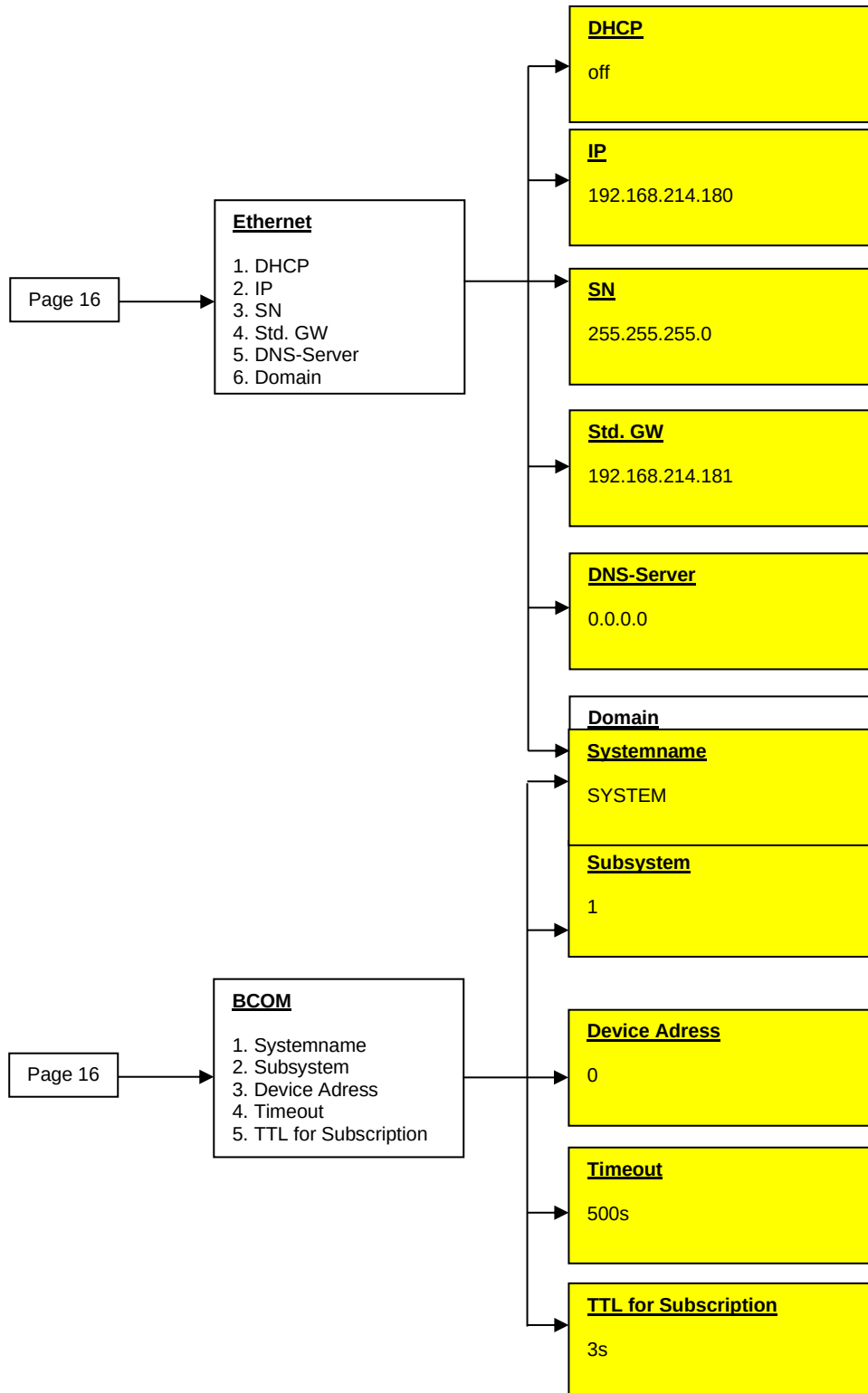












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Info

1/7 Device
iso685W-D_P
Ser.-Nr 1605510919
Art.-Nr. B91067030W

2/7 Software
Nr.: D440
Version: V1.10
Nr.: D439
Version: V1.10

3/7 Measurement-technique
Profile : Inverter >10Hz
System type: DC

4/7 EDS
PGH: Standard
Current: 10mA
Mode: auto

5/7 Clock
Time:
Date:
Summertime: CEST

6/7 Ethernet
IP: 192.168.214.180
DHCP: off
MAC: e0aeb20020c2

7/7 BS-Bus
Address: 1

2.2 Recommended settings for Bender iso685 in crane applications with IT supply

Table 2-1 Bender iso658 settings

Parameter	Value of MASTERDRIVES ¹⁾	Value of SINAMICS ²⁾
<i>ISO Setup</i>		
1. Exit		
2. Alarm 1	30 kΩ	30 kΩ
3. Alarm 2	10 kΩ	10 kΩ
4. K1	N.C. Test	N.C. Test
5. K2	N.C. Test	N.C. Test
6. SETUP2	Off	Off
7. M+ / M-	0-20 mA	0-20 mA
<i>ISO Advanced</i>		
1. Exit		
2. AGH	150 AK 160	NO
3. Ce max	500 μF	500 μF
4. Measure	AMP	AMO
5. Autotest	24h	24h
6. Clock		
7. Date		
8. Test	12:00	12:00
<i>Service</i>		
<i>Password</i>	842	842
2. Messp.	AMP	AMP
3. Ce max	500 μF	500 μF
4. F max	10 Hz	10 Hz
5. F min	0.1 Hz	0.1 Hz
6. # Pulse	3	3
7. Range	4	4
8. Standby	Off	Off
9. F1 F2	Reset	Reset
10. GL Fakt	00	00

1) Value of MASTERDRIVES with IMD connected to DC bus via coupling device AGH

2) Value of SINAMICS with IMD connected to input infeed (AC side)

3 Appendix

3.1 Service and support

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- Spare parts services
- Repair services
- On-site and maintenance services
- Retrofitting and modernization services
- Service programs and contracts

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support.industry.siemens.com/cs/ww/en/sc/2067

3.2 Industry Mall



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3.3 Application support

Siemens AG
 Digital Industries
 Motion Control
 Cranes
 DI MC GMC CR
 Frauenausracher Str. 80
 91056 Erlangen, Germany
 mailto: applications.cranes.aud@siemens.com

3.4 Links and literature

Table 3-1

No.	Topic
\1\	Siemens Industry Online Support https://support.industry.siemens.com
\2\	Link to this entry page of this application example https://support.industry.siemens.com/cs/ww/en/view/48958265
\3\	FAQ about Drives Technology – Power supply systems http://support.automation.siemens.com/WW/view/en/25220071
\4\	More information about use of the Bender insulation monitoring devices http://www.bender-de.com/home_en.html
\5\	Wolfgang Hofheinz, "Protective measures with insulation monitoring", 2nd edition 2000, VDE Verlag Berlin/Offenbach, ISBN 3-8007-2516-9
\6\	Information about power supply systems and surge arresters www.dehn.de
\7\	FAQ ID:10035164, Operation with unearthed supplies http://support.automation.siemens.com/WW/view/en/10035164
\8\	FAQ ID:23119516: How to remove Y capacitors http://support.automation.siemens.com/WW/view/en/23119516
\9\	Siemens Cranes, AP11: Sizing and Configuring SINAMICS Active Line Module https://intranet.automation.siemens.com/mcms/mc/de/dienstleistungen/technical-consulting/applikationssupport/standard-applikationen-uebersicht/Seiten/standard-applikationen-uebersicht.aspx

3.5 Change documentation

Table 3-2

Version	Date	Modifications
V1.0	05/2018	First version
V1.1	05/2020	REVIEW (Second Version)
V1.2	01/2022	Third version